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(54) **Electric discharge tube.**

(57) Flat and slightly convex pyrolytic graphite grid electrodes are very suitable for use in electric discharge tubes, for example in ion sources, cathode-ray tubes, travelling waveguides and transmitter tubes. It has proved possible to manufacture said electrodes by manufacturing the grid and the grid holder of the pyrolytic graphite electrode from one piece of pyrolytic graphite. Such integral grid electrodes have a very good mechanical and thermal behaviour.

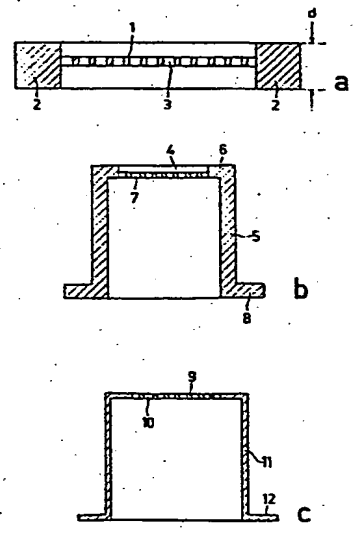

FIG.1

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"Electric discharge tube".

The invention relates to an electric discharge tube comprising in an evacuated envelope a grid electrode having a substantially flat grid of pyrolytic graphite which is provided in a grid holder.

An electric discharge tube is a tube in which a beam or a flow of electrons and/or ions is generated, for example, an ion source, a cathode-ray tube, a travelling wavetube or a transmitter tube. Pyrolytic graphite is a synthetic form of carbon which is obtained on a suitable substrate or mandril by deposition of elementary carbon from a carbon-containing gaseous phase. By previously determining defined deposition parameters it is possible to manufacture layers of pyrolytic graphite which are distinguished by a pronounced anisotropy of a number of physical properties. A detailed description of the deposition process is found, for example, in "Carbon" 5 (1967), pp.205-217 and in "Philips Technisch Tijdschrift" 28 (1967), pp. 133-144.

A method of manufacturing a grid electrode having a flat pyrolytic graphite grid is disclosed in United States Patent Specification 4,245,379. Said Specification describes how a flat pyrolytic graphite grid can be obtained by cutting a disc from a cylinder of pyrolytic graphite, then grinding it, providing it with apertures and stretching it in a grid holder. Such a method was necessary because so far it had proved impossible to manufacture directly thin flat pyrolytic graphite grids having a thickness of less than 100 /um by means of epitaxial growth on a hot mandril. This was impossible as a result of stresses which were generated in the grown layer during the cooling process. The method described in the said United States Patent Specification 4,245,379, however, has the disadvantage of being very laborious and the grid has to be

stretched in a grid holder. Another disadvantage is that the heat transport from the grid to the holder is not optimal so that at high thermal loads the possibility exists of the grid becoming too hot.

It is therefore an object of the invention to provide an electric discharge tube in which the grid need not be stretched in a grid holder and the heat transport from the grid to the grid holder is optimal.

For that purpose, an electric discharge tube of the kind described in the opening paragraph is characterized according to the invention in that the grid holder also consists of pyrolytic graphite and is integral with the grid. It is indeed impossible to manufacture thin flat pyrolytic graphite grids having a thickness of approximately 100 /um by means of epitaxial growth on a hot mandril. It is possible, however, to manufacture a thick flat layer of pyrolytic graphite which does not warp upon cooling. It is also possible to manufacture a cup-shaped body of thick or thin (100-200 /um) pyrolytic graphite having a flat or slightly convex bottom. By using a disc of thick flat pyrolytic graphite and making the central portion thereof locally thinner by means of, for example, spark erosion or sand blasting, and then cutting a grid in the thinned part by means of, for example, a laser beam or an electron beam or by means of spark erosion or sand blasting, a grid electrode is obtained whose grid is integral with the grid holder. It is also possible to use a cup-shaped body of pyrolytic graphite. If the bottom of such a cup-shaped body is thick, a local thinning can be provided therein in the manner described, after which the grid apertures can be formed. It is also possible, however, to start from a cup-shaped body of thin pyrolytic graphite. A local thinning then is not necessary so that the grid apertures can be directly provided in the bottom. In such a cup-shaped grid electrode, the grid is kept stretched by the mechanically rigid cylinder wall. When a cup-shaped body of pyrolytic graphite having a slightly convex bottom is used as the starting material, it is also

possible to manufacture slightly convex grids. If the cup-shaped electrode comprises a radially extending flange at its open end, this may serve for the assembly in the electric discharge tube.

A great advantage of manufacturing the grid and the grid holder as one assembly is that the heat transport from the grid to the grid holder is optimal. This is because the thermal conductivity in the direction parallel to the surface of the pyrolytic graphite is large. The pyrolytic graphite cylinder of a cup-shaped electrode moreover also serves as a heat radiator.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which

Figures 1a, 1b and 1c are longitudinal sectional views of a number of possible embodiments of grid electrodes according to the invention,

Figure 2 is a longitudinal sectional view of a cathode-ray tube having such an electrode, and

Figure 3 is a elevation, partly broken away, of a planar transmitter tube having such an electrode.

Figures 1a to 1c are longitudinal sectional views of a number of possible pyrolytic graphite grid electrodes for use in electric discharge tubes according to the invention. The grid electrode shown in Figure 1a comprises a 100 /um thick pyrolytic graphite grid 1 which is integral with the annular grid holder 2. The grid holder 2 has a thickness d of 2 mm. Said grid holder 2 and the pyrolytic graphite grid 1 are manufactured from a 2 mm thick disc of pyrolytic graphite which locally has been made thinner in the central part. The apertures 3 have then been provided in said thinner part by means of a - laser beam. It has proved possible to provide 10 to 15 apertures per mm beside each other. The apertures in Figures 1a, b and c are shown diagrammatically only. Because the grid holder 2 and the grid 1 have been manufactured from one piece of pyrolytic graphite, the heat transport from the grid which, for example, is exposed to an electron bom-

bardment, t the grid holder 2 is optimal.

The grid electrode of Figure 1b is cup-shaped and comprises a 75 /um thick grid 4 of pyrolytic graphite which is provided in the bottom of the cup-shaped electrode. The grid holder in this case consists of the cylinder wall 5 and a part 6 of the bottom. The grid 4 has been obtained by locally thinning the bottom of a 1 mm thick cup-shaped body of pyrolytic graphite and then providing the apertures 7. The cup-shaped electrode comprises a radially extending flange 8 at its open end.

The grid electrode shown in Figure 1c is also cup-shaped. This electrode, however, is manufactured from a thin cup-shaped pyrolytic graphite body (thickness 400 /um) in which the grid apertures 10 have been provided in the bottom. The grid 9 remains stretched because it is integral with the cylinder wall 11 which moreover comprises a radially extending flange 12.

Flange 8 of Figure 1b and flange 12 of Figure 1c may be used to connect the electrodes in a tube.

Figure 2 is a longitudinal sectional view of a cathode-ray tube having an electrode as shown in Figure 1. It comprises a glass envelope 20 which is composed of a display window 21, a cone 22 and a neck 23. A display screen 24 which comprises a thin phosphor layer is provided on the inside of the display window 21. An electron gun 25 for generating an electron beam 26 is present in the neck 23. Said electron gun 25 comprises, centred around an axis 32, a cathode 27, a first electrode 28, a second electrode 29, a third electrode 30 and a fourth electrode 31. The electron beam 26 is deflected over the display screen 24 in two mutually perpendicular directions by means of a system 33 of deflection coils and describes a frame on said display window.

In the non-prepublished Netherlands Patent Application 8200691 (PHN 10,273) it is described that the spherical aberration of the electron beam can be reduced by placing a grid (gauze) in the accelerating focusing lens of an electron gun. A pyrolytic graphite grid electrode

as shown in Figure 1c as the fourth gun electrode 31 is particularly suitable due to its good mechanical, thermal and electrical properties.

Figure 3 is an elevation, partly broken away, of a transmitter tube having flat electrodes. This tube comprises an envelope 40 having connection pins 41. The envelope 40 is composed of two annular parts 42 and 43 and two cup-shaped parts 44 and 45. Electrodes 46, 47 and 48 are connected between said parts by means of a sealing connection. Electrode 47 is a control grid of pyrolytic graphite as shown in Figure 1b. Because the grid 49 is integral with the grid holder 50, the thermal energy heat generated in the grid is very readily dissipated to the envelope.

CLAIMS

1. An electric discharge tube comprising in an evacuated envelope a grid electrode having a substantially flat grid of pyrolytic graphite which is provided in a grid holder, characterized in that the grid holder also consists of pyrolytic graphite and is integral with the grid.

2. An electric discharge tube as claimed in Claim 1, characterized in that the grid holder is annular and in the direction at right angles to the centre of the grid surface is thicker than the grid.

3. An electric discharge tube as claimed in Claim 1, characterized in that the grid electrode is cup-shaped and the grid forms at least a part of the bottom of said cup-shaped electrode and the grid holder is formed at least by the cylinder wall of the cup-shaped grid of the grid electrode.

4. An electric discharge tube as claimed in Claim 3, characterized in that the cup-shaped grid electrode comprises a radially extending flange at its open end.

5. An electric discharge tube as claimed in any of the preceding Claims, characterized in that the grid is slightly curved.

6. An electric discharge tube as claimed in any of the preceding Claims, characterized in that the tube is a cathode-ray tube.

7. An electric discharge tube as claimed in any of the Claims 1-4, characterized in that the tube is a planar transmitter tube.

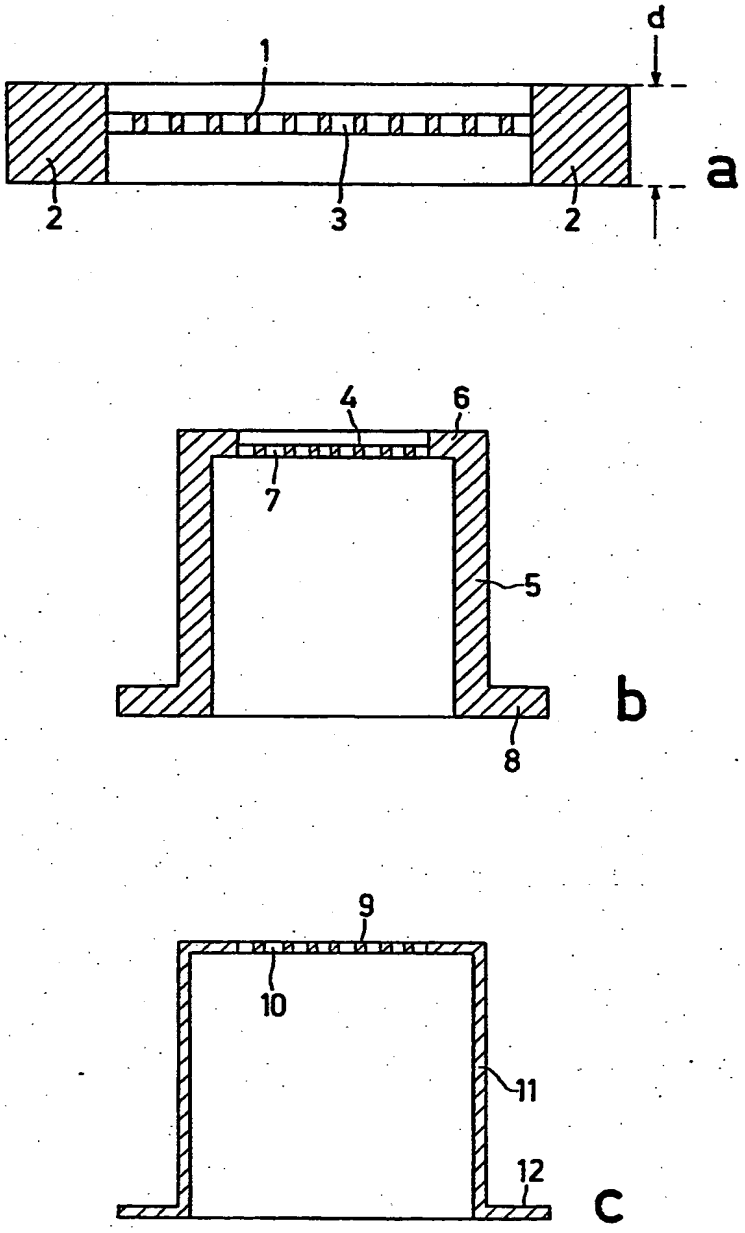

FIG.1

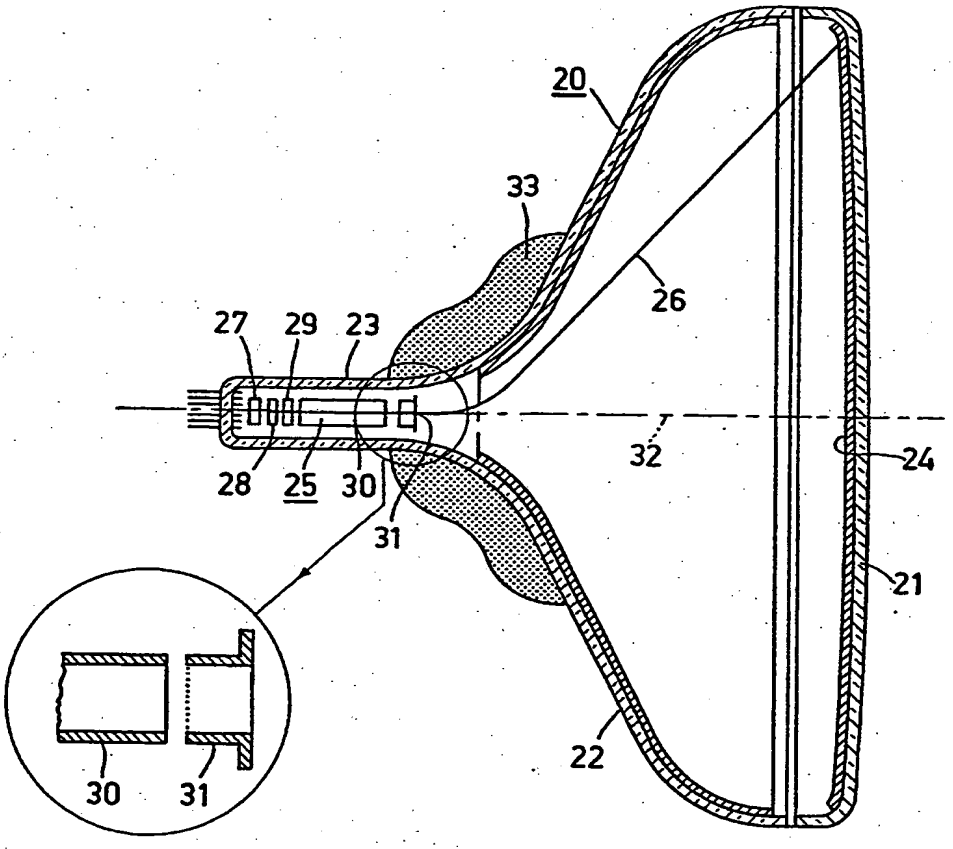
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FIG.2

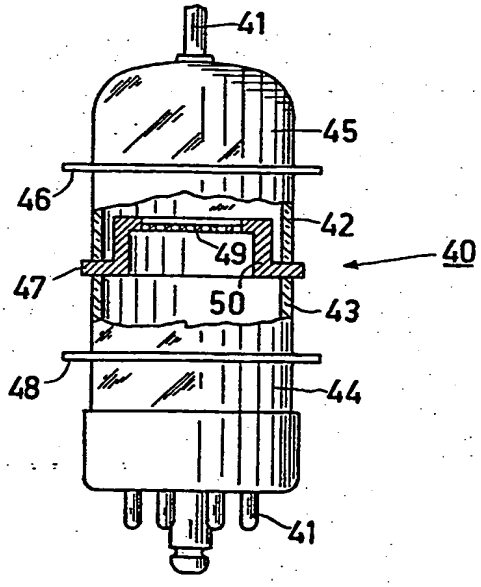
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FIG.3

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EUROPEAN SEARCH REPORT

0116377
Application number

EP 84 20 0031

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	FR-A-2 368 795 (ENGLISH ELECTRIC VALVE) * Figure; page 1, lines 26-35 *	1	H 01 J 1/48 H 01 J 9/14 H 01 J 19/28 H 01 J 19/48
Y	PATENTS ABSTRACTS OF JAPAN, vol. 14, 1977, page 9234 E 77 & JP - A - 52 110 568 (TOKYO SHIBAURA DENKI K.K.) 16-09-1977 * Abstract *	1	
A	GB-A-2 093 270 (J.S. SERGEEV et al.)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

H 01 J 1
H 01 J 9
H 01 J 19
H 01 J 29

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-05-1984	SCHAUB G.G.

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